

form understood by those skilled in the art to mean that particles are capable of passing through a mesh of "X" but not capable of passing through a mesh of larger than "Y". In the absence of the language X to Y mesh meaning this (as Applicant has elaborated on in the December 8, 2005 Amendment), the upper range (the "Y" value) would be meaningless. That is, if the inclusion of the upper mesh value does not eliminate particles capable of passing therethrough, it would not have to be stated.¹

Still further, to describe a particle as passing through a mesh of "X", inherently means that a range of particle sizes passes therethrough, unless the particle size is expressly described to be the same. Applicant has not described, or inferred, that the particle size is the same anywhere in its specification.

As evidence of this common usage of this language (precisely as used by the Applicant), Applicant is enclosing herewith several articles. The articles each bear the web site identification on the top thereof.

Attachment A uses the language "X to Y mesh" as used by the Applicant. As can be seen, the different mesh ranges separate a range of different particle sizes. The smaller mesh numbers, which account for larger opening sizes, produce a larger average particle size.

Similar language is used in Attachments B, C and D.

Attachment E uses similar terminology but uses a slight variation of this convention; "X/Y mesh" versus "X to Y mesh". However, as explained on the cover page of

¹ This explanation is further supported by the description in Applicant's specification, on pages 16-18.

Attachment E, and as highlighted thereon, 32/42-mesh defines a material size that passes through 32 mesh but is trapped in a 42 mesh sieve.

It is respectfully submitted that the terminology that Applicant has used since the original filing of its application is conventionally known to mean that a mesh of "X to Y" includes a range of particle size capable of passing through a mesh of X but not capable of passing through a mesh larger than Y. Accordingly, the language added in the December 8, 2005 Amendment is fully supported by the original disclosure.

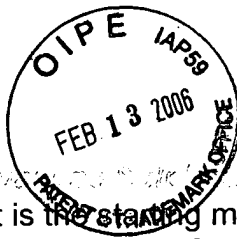
With this clarification, it is believed that all pending claims are in allowable form. Entry of the December 8, 2005 amendment and allowance of the case are requested.

Respectfully submitted,

By 
John S. Mortimer, Reg. No. 30,407

WOOD, PHILLIPS, KATZ,
CLARK & MORTIMER
500 W. Madison St., Suite 3800
Chicago, IL 60661
(312) 876-1800

Date: Feb 8, 2006

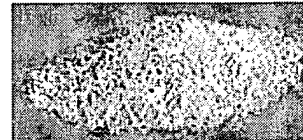


Products Introduction

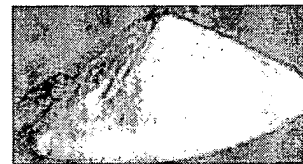
Uses: It is the starting material for electrolytic manganese metal, electrolytic manganese dioxide, fungicide and other manganese compounds including manganese carbonate, manganese salt for drying and inorganic pigments. It is also used in textile printing and glass making. Very significant in terms of volume, it is used as fertilizer for manganese-deficient soil and additive for animal feeds.

Specifications:

| | |
|---|-------------|
| Purity($\text{MnSO}_4 \cdot \text{H}_2\text{O}$): | 98%min. |
| Manganese(Mn): | 31.8%min. |
| Iron(Fe): | 0.004%max. |
| Chloride(Cl): | 0.004%max. |
| Water insoluble: | 0.05%max. |
| Heavy metal(Pb): | 0.0015%max. |
| Arsenic(As): | 0.0005%max. |
| PH value: | 5-7 |



6-10 mesh



powder

Sizes: (powder) 60-100 mesh;
(granular) 6-10 mesh or 10-50 mesh.

Packing:

Net Weight: 25, 50kgs P.P. woven bag with pe liner; or 1000 kgs big bags

2. Zinc Sulphate(ZnSO_4)

Uses: It is used as raw material for production of lithopone. It is also used in synthetic fiber industry, zinc plating, pesticides. It is mainly used in trace element fertilizer and feed additive, etc.

Specifications:

(1) Zinc Sulphate Monohydrate($\text{ZnSO}_4 \cdot \text{H}_2\text{O}$):

| | |
|---|-------------|
| Purity($\text{ZnSO}_4 \cdot \text{H}_2\text{O}$): | 98%min. |
| Zinc(Zn): | 35%min. |
| Water insoluble: | 0.05%max. |
| Heavy metal(Pb): | 0.0015%max. |
| Arsenic(As): | 0.0005%max. |
| PH value: | 5-7 |



10-20 mesh



powder

Sizes: (powder) 60-100 mesh;
(granular) 6-10 mesh or 10-50 mesh.

Attachment A

1/2

Packing:

Net Weight:25,50kgs P.P. woven bag with pe innerbag;or 1000 kgs big bags.

(2)Zinc Sulphate Heptahydrate($\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$):

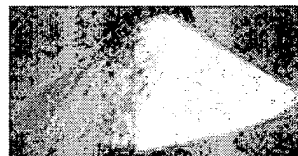
| | |
|--|------------|
| Purity($\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$): | 98%min. |
| Zinc(Zn): | 22%min. |
| Water insoluble: | 0.05%max. |
| Heavy metal(Pb): | 0.002%max. |
| Arsenic(As): | 0.001%max. |
| Cadmium(Cd): | 0.002%max. |

Sulfur Dioxide(SO2)

Uses: It is mainly used as bleaching agent for processing leathers,fabric and organic matter,medium colouring agent for printing and dyeing;germicide and antiseptic for food preserving,brewing and beverage. It is also used as auxiliary material for synthetic dyes,perfume and photographic fixing agent,etc.

Specifications:

| | |
|--------------------------------|-------------|
| Main content(SO_2): | 65%min. |
| Iron(Fe): | 0.005%max. |
| Water insoluble: | 0.05%max. |
| Heavy metal(Pb): | 0.002%max. |
| Arsenic(As): | 0.0002%max. |
| PH value: | 4.5-5.5 |

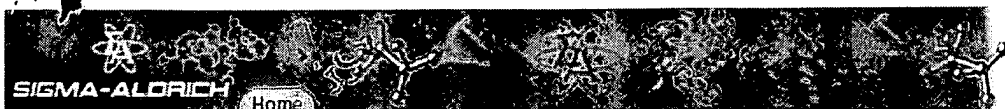


powder

Packing:

Net Weight:25,50kgs P.P. woven bag with pe liner;or 1000 kgs big bags.

2/2



Register for additional site benefits. | [Login](#) | [Your Profile](#) | [Order Center](#) | [Search](#) | [Support](#) | [Help](#)

Laboratory Essentials

- + Hematology and Histology
- + Virtual Lab
- + Biochemicals
- + EquipBasics
- + EquipBasics Europe
- + Chemicals
- LabBasics Europe
 - + Product Highlights
 - Product Lines
 - Acids and Bases
 - Adsorbents
 - Salts and Oxides
 - Solvents
 - Titration
- + Key Resources
- + MedBasics
- + Key Resources

Adsorbents

LabBasics - EU

| Product Name | Product # |
|--|-----------|
| Activated charcoal purum granulated | 18002 |
| Activated charcoal granular Pore Size 20-40 mesh | 242268 |
| Activated charcoal granular Pore Size 4-12 mesh | 242233 |
| Activated charcoal powder Pore Size ~100 mesh | 242276 |
| Activated charcoal pore volume ~1.5 cm ³ /g (dry basis) | 278092 |
| Activated charcoal decolorizing | 161551 |
| Activated charcoal | 329428 |
| Aluminum oxide standard grade Pore Size ~150 mesh Pore Size 58 Å | 199966 |
| Aluminum oxide standard grade Pore Size ~150 mesh Pore Size 58 Å | 199974 |
| Aluminum oxide standard grade Pore Size 58 Å Pore Size ~150 mesh Pore Size 58 Å | 199443 |
| Aluminum oxide powder Particle size 10 µm 99.7 % | 265497 |
| Ascarite® Sodium hydroxide-coated silica. Pore Size 8-20 mesh | 223913 |
| Ascarite® Sodium hydroxide-coated silica. Sodium hydroxide-coated silica. Pore Size 20-30 mesh | 223921 |
| Calcium sulfate with indicator Pore Size 4 mesh | 238961 |
| Calcium sulfate with indicator Pore Size 6 mesh | 456071 |
| Calcium sulfate with indicator Pore Size 8 mesh | 238988 |
| Calcium sulfate without indicator Pore Size 4 mesh | 238910 |
| Calcium sulfate without indicator Pore Size 6 mesh | 238929 |
| Calcium sulfate without indicator Pore Size 8 mesh | 238937 |
| Diatomaceous earth | 392545 |
| Filter agent, Celite® | 167436 |
| Filter agent, Celite® 521 | 221791 |
| Filter agent, Celite® 545 | 419931 |
| Filter agent, Celpure® P100 | 526266 |
| Filter agent, Celpure® P1000 | 525227 |
| Filter agent, Celpure® P300 | 525243 |
| Filter agent, Celpure® P65 | 525235 |
| Florisil® particle size 30-60 mesh | 288691 |
| Florisil® particle size 60-100 mesh | 220744 |
| Florisil® reagent grade particle size 60-100 mesh | 220752 |
| Florisil® particle size 100-200 mesh | 220736 |
| Florisil® Pore Size ~200 mesh | 288705 |
| Molecular sieves beads Pore Size 4-8 mesh | 208574 |
| Molecular sieves beads Pore Size 4-8 mesh | 208590 |
| Molecular sieves beads Pore Size 4-8 mesh | 208639 |
| Molecular sieves beads Pore Size 8-12 mesh | 208582 |
| Molecular sieves 4A beads Pore Size 8-12 mesh | 208604 |
| Molecular sieves beads Pore Size 8-12 mesh | 208647 |
| Molecular sieves pellets Particle size 1.6 mm | 334286 |
| Molecular sieves pellets Particle size 1.6 mm | 334308 |
| Molecular sieves pellets Particle size 3.2 mm | 334278 |
| Molecular sieves pellets Particle size 3.2 mm | 334294 |
| Molecular sieves powder Particle size 5 µm | 233668 |
| Molecular sieves, 5Å beads Pore Size 4-8 mesh | 208612 |
| Molecular sieves, 5Å beads Pore Size 8-12 mesh | 208620 |

Attachment B

1/2

| | |
|--|--------|
| Sand Pore Size -50-+70 mesh | 274739 |
| Silica gel ACS reagent | 336815 |
| Silica gel Davisil™ Pore Size 60 Å pore volume 0.75 cm ³ /g 99 % | 236756 |
| Silica gel Davisil™ Pore Size 60 Å pore volume 0.75 cm ³ /g 99+ % particle size 200-425 mesh | 236772 |
| Silica gel Davisil™ Pore Size 60 Å pore volume 0.75 cm ³ /g 99+ % particle size 100-200 mesh | 236780 |
| Silica gel Davisil™ Pore Size 60 Å pore volume 0.75 cm ³ /g 99+ % | 236799 |
| Silica gel Davisil™ Pore Size 60 Å pore volume 0.75 cm ³ /g 99+ % particle size 35-60 mesh | 236802 |
| Silica gel Davisil™ Pore Size 150 Å pore volume 1.15 cm ³ /g 99+ % particle size 200-425 mesh | 236810 |
| Silica gel Davisil™ 99+ % Pore Size 150 Å pore volume 1.15 cm ³ /g particle size 100-200 mesh | 236829 |
| Silica gel Davisil™ Pore Size 150 Å pore volume 1.15 cm ³ /g 99+ % particle size 60-100 mesh | 236837 |
| Silica gel 99+ % Pore Size 150 Å pore volume 1.15 cm ³ /g Davisil™ particle size 35-60 mesh | 236845 |
| Silica gel Merck™ Pore Size 60 Å particle size 230-400 mesh | 227196 |
| Silica gel Merck™ Pore Size 40 Å pore volume 0.68 cm ³ /g particle size 35-70 mesh | 242179 |
| Silica gel Merck™ Pore Size 60 Å particle size 70-230 mesh | 391484 |
| Silica gel Merck™ average Mw <500 particle size 63-200 µm Pore Size 70-230 mesh | 403563 |
| Silica gel Merck™ high purity particle size 63-200 µm particle size 70-230 mesh | 403598 |
| Silica gel Merck™ particle size 63-200 µm Pore Size 100 Å particle size 70-230 mesh | 403601 |
| Silica gel Merck™ with gypsum binder and fluorescent indicator TLC grade 7749 | 346446 |
| Silica gel TLC grade 11678 average particle size 15 µm with gypsum binder and fluorescent indicator pore diameter 60 Å | 403717 |
| Silica gel TLC grade 11695 average particle size 15 µm with silica/alumina binder pore diameter 60 Å | 403709 |
| Silica gel Particle size 100-200 mesh (75-150 µm) Pore Size 25 Å (average pore diameter) | S4133 |
| Silica gel particle size 28-200 mesh | 214396 |
| Silica gel Pore Size 30-60 mesh | 214418 |
| Silica gel Pore Size 6-12 mesh | 214426 |
| Silica gel Pore Size 3-9 mesh | 214434 |
| Silica gel particle size 6-16 mesh | 214442 |
| Silica gel particle size 14-20 mesh | 214450 |
| Silica gel particle size 100-200 mesh | 214477 |
| Silica gel Pore Size 150 Å particle size 60-200 mesh | 243981 |
| Silica gel particle size 8 mesh | 249823 |
| Silica gel Pore Size -200 mesh | 270172 |
| Silica gel Pore Size 60 Å pore volume 0.75 cm ³ /g particle size 200-400 mesh | 288594 |
| Silica gel Pore Size 60 Å pore volume 0.75 cm ³ /g particle size 130-270 mesh | 288608 |
| Silica gel Pore Size 60 Å pore volume 0.75 cm ³ /g particle size 70-230 mesh | 288624 |
| Silica gel particle size 60-200 mesh | 343323 |
| Silica gel Type II Particle size 1/8 in. (beads) Suitable for desiccation | S7500 |
| Silica gel Type III Indicating For desiccation | S7625 |
| Silica gel | S8394 |

Use of this web site constitutes your acceptance of the Site Use Terms

[help](#) | [privacy](#) | [technical library](#) | [search](#) | [home](#)
[terms and conditions](#) | [contract manufacturing](#)

© 2006 Sigma-Aldrich Co. Reproduction forbidden without permission.
Sigma-Aldrich brand products are sold exclusively through Sigma-Aldrich, Inc. Best viewed in IE6 or higher

2/c

Liming Acid Soils in Tennessee

High Saucy, Jr., Associate Professor, Biosystems Engineering & Environmental Science
Originally written by John R. Jarek, Former Professor Plant and Soil Science

Soil test results indicate that approximately 50 percent of the cropland in Tennessee is too acid for optimum crop production. Because of this, determining the need for lime should be the first step in developing a sound crop fertilization program. Lime neutralizes excess soil acids and increases pH. If not limed as needed, soils continue to become more acid, reducing the soil's potential to produce healthy plants and profitable yields.

What is Soil Acidity?

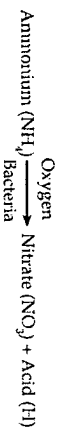
Soil acidity refers to the level of acids present in soils. As acid levels increase, the pH of the soil decreases. While the pH scale ranges from 0-14, most Tennessee soils range in value from 4.5 to 7.5. Soils with pH values greater than 7.0 are alkaline or sweet, and those with values of less than 7.0 are acid or sour (Figure 1). As the soil pH decreases below 7.0, the amount of acidity rapidly increases. For example, a pH of 5.0 is 10 times more acid than 6.0 and 100 times more acid than pH 7.0.



Figure 1. The pH Scale (Source: NCSA).

Causes of Soil Acidity

Several factors contribute to soil acidity. Acid levels increase as basic nutrients (calcium, magnesium, potassium) are replaced by hydrogen through soil erosion, leaching and crop removal. In addition, the use of acid-forming fertilizers greatly enhances acid levels. In particular, the conversion of ammonium (NH₄) nitrogen to nitrate (NO₃) nitrogen in the soil (nitrification) produces significant amounts of acid (H) as follows:



As a result, about 3 to 4 pounds of agricultural limestone are needed to correct the acidity formed from each pound of actual nitrogen applied to the soil from either ammonium nitrate, urea, UAN solutions or anhydrous ammonia.

Determining the Need for Lime (Water pH)

Soil pH is determined in the University of Tennessee Soil Testing Laboratory with the glass electrode using 10 grams of soil in 10 milliliters of deionized water. The value obtained is a measure of the degree of acid in the soil solution and is used to indicate whether or not lime is needed (Figure 2). It is the value referred to on soil test report forms as water pH.

Determining the Amount of Lime (Buffer pH or Buffer Value)

While water pH indicates the need for lime, buffer pH determines how much to apply. Buffer pH is a measure of the amount of acid held (adsorbed) by soil particles (clay, organic matter) and accounts for the acid that must be neutralized when lime is added. Buffer pH is reported as buffer value on all University of Tennessee soil test report forms.

The relation between water and buffer pH readings may be more easily understood by considering the relation between the fuel gauge and fuel tank in an automobile. The gauge indicates the relative need for fuel but says nothing about the gallons required to fill up. This depends on the size of the tank. For example, if the tank holds 20 gallons and the gauge indicates it to be one-fourth full, then 15 gallons of fuel would be required to refill the tank. If the tank's

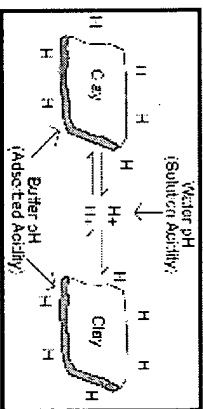


Figure 2. Relation between Water pH and Buffer pH.

capacity is 40 gallons, then 30 gallons of fuel would be necessary to refill the tank from one-fourth full.

When making lime recommendations, water pH is the "gauge" used to indicate the need for lime, while buffer pH is the "gauge" used to show how much lime should be applied to properly adjust the soil's pH, or "refill the tank." Clayey soils have more holding capacity or "larger tanks" than silty or sandy soils and require more lime to produce an equal amount of change in soil pH. Although water pH values may be similar for two or more soils, buffer pH values and recommended lime rates may differ greatly due to different clay levels and amounts of adsorbed acidity.

What Does Lime Do?

Applying lime to acid soils provides the following benefits:

1. Reduces amounts of soluble aluminum and manganese to non-toxic levels. As soil pH increases, the availability of manganese decreases, which prevents plants from taking up toxic amounts (Figure 3). Manganese toxicity becomes a major problem in many plants when the soil pH drops to near 5.0.
2. Supplies calcium, and if dolomitic limestone is used it supplies both calcium and magnesium, which are essential plant nutrients. Also, the availability of secondary and micronutrients is about optimum in the pH range of 6.1 to 6.5.
3. Increases the efficiency of N, P and K. For example, the efficiency of applied phosphate may be more than doubled when soil pH is increased from 5.0 to 6.1 because of less fixation or tie-up in the soil (Figure 4).
4. Enhances microorganism activity. Acid soils slow the growth and multiplication of certain microorganisms, which in turn reduces soil processes such as the release of nutrients from organic matter decomposition (mineralization) and nitrogen fixation in legumes.
5. Improves the effectiveness of certain herbicides (atrazine, etc.).
6. Increases yields and profits. University of Tennessee research indicates that three tons of limestone applied to soybean fields with soil pH values of 5.1 to 5.5 increased yields an average of 11 bushels per acre. In burley tobacco tests, yields were increased 1,024 pounds when four tons of limestone were applied to a soil with pH 4.4.

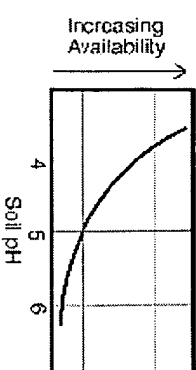


Figure 3. Influence of Soil pH on Manganese Availability.

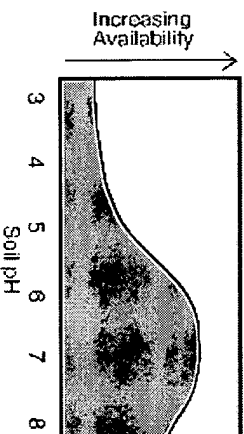


Figure 4. Influence of Soil pH on Phosphorus Availability.

When and How to Apply Lime

Although lime can be applied whenever soil, weather, crop and labor conditions permit, fall is an excellent time for spreading. Fields are usually dry, lime dealers are less rushed and growers are not occupied with spring planting.

Lime should be spread uniformly. Uneven distribution may present problems for several growing seasons since lime is not applied every year. The time interval between lime applications will vary depending upon soil type, weather conditions, cropping systems and fertilization (see Extension PB 1061).

Lime Sources

The primary function of a liming material is to correct acid soil conditions. Thus, materials that are easily spread and provide the greatest liming value at the least cost are the most desirable. The most common and economical liming material available in Tennessee is ground or agricultural limestone. Limestones containing both calcium and magnesium are DOLOMITIC. Those containing only calcium are

Attachment C 112

calcltic. When soils are acid and magnesium levels are deficient, a dolomitic limestone should be applied to increase both pH and magnesium levels. Dolomitic limestones sold in Tennessee usually contain about 9 percent magnesium.

If other materials are used, equivalent amounts should be applied (Table 1). For example, one ton of calcitic limestone is equivalent in potential neutralizing value to about 1,500 pounds of calcium hydroxide or 3,000 pounds of basic slag.

Pelletized lime

Pelletized lime is produced by binding or compressing smaller lime particles into larger granules or pellets. The larger particle are easier to spread and create less dust when handling. For this reason, pelletized lime is often the choice for lawn and garden use. However, if the pellets do not readily stake or break down when in contact with rain or irrigation, their effectiveness in raising soil pH may be reduced. The cost of pelletized lime is usually greater than conventional lime sources because of the added expense in processing.

State liming law

The Tennessee Liming Materials Act requires that no liming material be offered for sale that does not have a minimum calcium carbonate equivalent of 75. It must also be ground so that at least 85 percent passes through a 10-mesh sieve and at least 50 percent passes through a 40-mesh sieve. In addition, liming materials sold must have a relative neutralizing value (RNV) of 65 or greater to meet state requirements.

| Material | Calcium Carbonate Equivalent | Pounds to Equal One Ton of Pure Calcium Carbonate |
|-------------------------|------------------------------|---|
| Limestones | | |
| Pure | 100 | 2000 |
| Calcitic | 85-100 | 2360-2000 |
| Dolomitic | 95-109 | 2100-1890 |
| Calcium Hydroxide | | |
| Hydrated or Slaked lime | 135 | 1480 |
| Calcium Oxide | | |
| Burnt or Quick lime | 179 | 1120 |
| Basic Slag | 60-70 | 3330-2660 |

Table 1. Equivalent Amounts of the Liming Materials Based on Calcium Carbonate Equivalent.

Calcium carbonate equivalent, fineness of grind and the relative neutralizing value are required to be indicated in a conspicuous manner on the label or tag of bagged materials and on the delivery slip or invoice for materials sold in bulk.

NOTE: Sieve or mesh size refers to the number of openings per linear inch of screen. For example, a 40-mesh sieve contains 40 openings per linear inch or 1,600 openings per square inch.

Relative Neutralizing Value (RNV)

The relative neutralizing value of a liming material is determined by calculating the total particle size efficiency and multiplying by the calcium carbonate equivalent as follows:

| Percent Material in Each Size Range | Efficiency Factor | Particle Efficiency |
|-------------------------------------|-------------------|---------------------|
| 5 (coarser than 10 mesh) | x .33 | = 1.6 |
| 20 (10-40 mesh) | x .73 | = 14.6 |
| 40 (40-60 mesh) | x .93 | = 37.2 |
| 35 (finer than 60 mesh) | x 1.00 | = 35.0 |
| Total Particle Size Efficiency | | = 88.4 |

If the above material had a calcium carbonate equivalent (CCE) of 90 percent, the RNV would be: 88.4 (particle size efficiency) X .90 (CCE) = 79

The Importance of Limestone Quality

The quality of agricultural limestone is determined by calcium carbonate equivalent and fineness of grind. The calcium carbonate equivalent determines how much acidity a given amount of ground limestone will neutralize in the soil. Fineness of grind determines the rate limestone reacts with soil acids. Limestones coarser than 60-mesh will require from a few weeks to several months to produce significant changes in pH, while limestones 60-100 mesh will produce significant changes within two to three weeks when weather conditions are favorable and recommended amounts are applied (Figure 5). Limestones finer than 100 mesh produce results similar to 60-100 mesh materials when applied under similar conditions. Thus, small amounts of "extremely fine" liming materials should not be substituted for recommended amounts of good quality ground limestone. Also, extremely fine materials may be difficult to spread and handle.

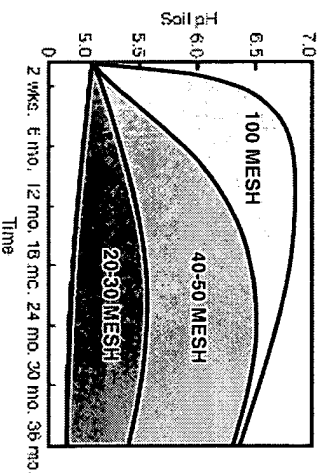


Figure 5. Relation between particle size and rate of change in soil pH when equal amounts of limestone are applied under similar conditions.

Agricultural limestones meeting state requirements usually contain adequate amounts of 60-100 mesh material.

Liming No-Till Soils

Lime is very important to no-till crops, especially corn where large amounts of nitrogen fertilizers are applied to the surface without incorporation. The nitrogen tends to produce extremely acid conditions in the top 2 inches of soil. If not neutralized, the acid will greatly reduce nutrient availability and herbicide activity, resulting in low fertilizer efficiency and poor weed control.

Where lime is needed, the same amount is recommended for no-till as for conventional practices. Research does not indicate any advantage to applying smaller amounts more frequently.

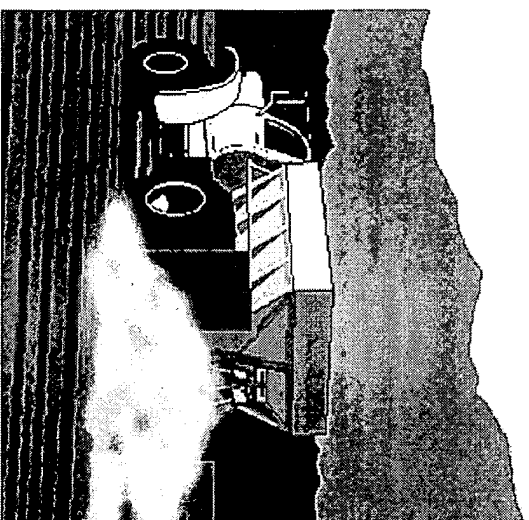
If soils are extremely acid initially (approximately 5.0 or less to several inches), root development and plant growth may be restricted unless the limestone is incorporated into the soil. Surface applications will require more time to neutralize acidity to greater depths than when incorporated into the soil.

Soil samples for determining pH should be collected to a depth of 6 inches for both conventional and no-till row crops and pastures.

04-0242 PB1096-2-5M-60M(Rev) E-12-4315-001-04

This Agricultural Extension Service publication is a project of the Tennessee Agricultural Experiment Station, which is a part of the Tennessee Department of Agriculture. The Tennessee Department of Agriculture is an equal opportunity employer. Minorities and women are encouraged to apply. This publication is available in Spanish and French. For more information, contact the Tennessee Department of Agriculture, 1000 Nashville Avenue, Nashville, Tennessee 37203.

Liming Acid Soils in Tennessee





Keyword Search

in Site

Go

Go

Go

[Home](#)[About LGC
Promochem](#)[Contact us](#)[Browse products](#)[Simple search](#)[Advanced search](#)[Catalogues](#)[Register](#)[Log in](#)[Enquiry form](#)[News and events](#)[LGC](#)[ATCC](#)[Impurities from
LGC](#)[Terms and
conditions](#)

Browse our reference material catalogues

To help you find the reference materials that are right for you, please click on the headings below which reflect those in the hard copy catalogues.

For up to date pricing and details of discounts available on bulk orders, please contact your local office.

Products in this category

1 (11 products found)

| Product | |
|---|------|
| Florisil PR for residue analysis. 60 - 100 mesh (150 - 250 um) SC-4182-B005 Size: 500g | More |
| Florisil PR for residue analysis. 60 - 100 mesh (150 - 250 um) SC-4182-S010 Size: 10kg | More |
| Florisil (Standard). 60 - 100 mesh (150 - 250 um) SC-4181-B005 Size: 500g | More |
| Florisil (Standard). 60 - 100 mesh (150 - 250 um) SC-4181-S010 Size: 10kg | More |
| ICN Alumina B - Super I (basic) (50 - 200 um) SC-4568-B005 Size: 500g | More |
| ICNAlumina B - Super I (50 - 200 um) SC-4569-B005 Size: 500g | More |
| ICNAlumina A - Super I (acid) (50 - 200 um) SC-4592-B005 Size: 500g | More |
| Silica gel 60 (63 - 200 um) SC-9982-B010 Size: 1kg | More |
| Sodium sulfate, anhydrous granular (ACS) SC-8024-B005 Size: 500g | More |
| Sodium sulfate, anhydrous granular (ACS) SC-8024-B025 Size: 2.5kg | More |
| Sodium sulfate, anhydrous granular (ACS) SC-8024-S025 Size: 25kg | More |

1 (11 products found)

Choose a category to see its sub-categories

Catalogues

High purity solvents

Reagents / Sorbents

<< back

Effect of Particle Size on Mixing Degree in Dispensation

Hitoshi NAKAMURA,^a Yoshitsugu YANAGIHARA,^a Hiroko SEKIGUCHI,^b Michiteru OHTANI,^b
Satoru KARIYA,^b Katsuyoshi UCHINO,^b Hiroshi SUZUKI,^a and Tatsuji IGA^{*,a}

*Department of Pharmacy, The University of Tokyo Hospital, Faculty of Medicine, The University of Tokyo,
7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8655, Japan and Department of Hospital Pharmacy, Tokyo Postal
Service Agency Hospital,^b 2-14-23 Fujimi, Chiyoda-ku, Tokyo 102-8798, Japan*

(Received September 26, 2003; Accepted December 11, 2003)

By using lactose colored with erythrocine, we examined the effect of particle size on mixing degree during the preparation of triturations with a mortar and pestle. We used powders with different distributions of particle sizes, i.e., powder that passed through 32-mesh but was trapped on a 42-mesh sieve (32/42-mesh powder), powder that passed through a 42-mesh sieve but was trapped on a 60-mesh sieve (42/60-mesh powder), powder that passed through a 60-mesh sieve but was trapped on a 100-mesh sieve (60/100-mesh powder), and powder that passes through a 100-mesh sieve (>100-mesh powder). The mixing degree of colored powder and non-colored powder whose distribution of particle sizes was the same as that of the colored powder was excellent. The coefficient of variation (CV) value of the mixing degree was 6.08% after 40 rotations when colored powder was mixed with non-colored powder that both passed through a 100-mesh sieve. The CV value of the mixing degree was low in the case of mixing of colored and non-colored powders with different particle size distributions. After mixing, about 50% of 42/60-mesh powder had become smaller particles, whereas the distribution of particle sizes was not influenced by the mixing of 60/100-mesh powder. It was suggested that the mixing degree is affected by distribution of particle sizes. It may be important to determine the mixing degrees for drugs with narrow therapeutic ranges.

Key words—dispensation; trituration; particle size; granules

INTRODUCTION

The degree of mixing in trituration is affected by many factors, including the physical property and mixing ratio of the principal agents and diluents, the mixing conditions and the kind of blender used. Many studies using a V-type blender have been performed to determine the effects of various factors on mixing degree.^{1–4)} However, there has been little investigation of the effects of factors on the degree of mixing using a mortar and pestle, which are frequently used in hospitals and general pharmacies. It has been reported that a satisfactory degree of mixing cannot be achieved by using a mortar and pestle when powders and granules are mixed.⁵⁾ It has also been reported that the uniform mixing was achieved by using a mortar and pestle after 60–80 rotations in the case of preparation of 5.0–30.0 g of powdered medicine when the gravity of the principal agent and that of diluents was similar.^{6–8)} In contrast to the fact that an excellent degree of mixing was achieved when powders with similar particle sizes were used, it has been


reported that the mixing degree of powders with different particle sizes was unsatisfactory. Although the 10th edition of the Japanese Guidelines for Dispensation indicates that medicines can be prepared by mixing powders and fine granules, there is no detailed information on the mixing degree of powders and fine granules.

In the present study, by using lactose colored with erythrocine, a food-coloring agent, we examined the effect of particle size on mixing degree during the preparation of triturations with a mortar and pestle, which are generally used for dispensation.

MATERIALS AND METHODS

Preparation of Lactose Lactose powder (20 g, lot number 099208, Yoshida Seiyaku Co., Ltd., Tokyo, Japan) was transferred to a glass mortar, and erythrocine (2 g, lot number GG41HH, Tokyo Kasei Kogyo Co., Ltd., Tokyo, Japan) dissolved in 5 ml of distilled water was added to the mortar and mixed well. After addition of the remaining lactose powder (78 g), the solution was mixed until it was homogeneous and was then passed through a 32-mesh dispensing sieve (screen size of 500 μ m). After dehydration

e-mail: igat-ky@umin.ac.jp

Attachment  11/5

at 60°C for 1 h using a circulating warm-air dehydrator, the resulting pellet was sieved through 100-mesh (screen size of 149 μm), 60-mesh (screen size of 250 μm), 42-mesh (screen size of 350 μm) and 32-mesh (screen size of 500 μm) dispensing sieves. We could thus obtain powders with different distributions of particle sizes, i.e., powder that passed through a 32-mesh sieve but was trapped on a 42-mesh sieve (32/42-mesh powder), powder that passed through a 42-mesh sieve but was trapped on a 60-mesh sieve (42/60-mesh powder), powder that passed through a 60-mesh sieve but was trapped on a 100-mesh sieve (60/100-mesh powder), and powder that passed through a 100 mesh sieve (>100 -mesh powder). Diluents were prepared from powdered lactose according to the method described above by using 5 ml of distilled water free of erythrocine.

Methods of Mixing A china mortar with an outer diameter of 10 cm and depth of 5.5 cm (Nik-katou Seiyaku, Tokyo, Japan) was used. The mortar was held and rotated by the left hand, and the pestle was rotated spirally in the direction opposite to that of the rotation of the mortar. For the mixing, 10 clockwise rotations followed by 10 anticlockwise rotations were repeated three times, the mortar thus being rotated 60 times. Rotation was performed at a constant rate (60 rotations/30 sec). In the present study, 10 g of colored lactose powders (>100 -mesh, 60/100- and 42/60-mesh powders), and the same amount of diluent lactose (>100 -, 60/100-, 42/60- and 32/42-mesh powders) were mixed in the mortar.

Determination of Particle Size After mixing, the distribution of particle sizes was determined by sieving the mixed powders through 32-, 42-, 60-, 80-, 100-, 150- and 200-mesh prescription sieves with screen sizes of 500, 350, 250, 177, 149, 105 and 74 μm , respectively.

Estimation of Mixing Degree After mixing, 1.0 g specimens were randomly taken from three portions of the mixed powders to determine the concentration of erythrocine. Each specimen was dissolved in distilled water to obtain a solution of 10 ml. The absorption at the wavelength of 524 nm was determined by using a spectrophotometer (UV-160, Shimadzu Co., Ltd., Kyoto, Japan).

Assuming that the contents of the major agents in the triturations were distributed according to the normal probability distribution, the coefficient of variation (CV) value was 6.08% under conditions in

which 90% of the powder fraction contained 100 ± 10 % of the expected amount of the major agent.⁹⁾ Therefore, the mixing degree was judged as excellent if the CV value of three determinations of erythrocine concentration in each preparation was less than 6.08 %.

RESULTS

Effect of Particle Size on Mixing Degree At first, we examined the mixing degrees of colored lactose having particle size of >100 -mesh with diluent lactose having particle sizes of >100 -, 60/100-, 42/60- and 32/42-mesh. The CV of the mixing degree became less than 6.08% after 40 rotations in the case of diluent lactose with particle size of >100 -mesh (Fig. 1). In contrast, 60 rotations were required to achieve a CV value of less than 6.08% in the case of diluent lactose with particle sizes of 60/100-, 42/60- and 32/42-mesh (Fig. 1).

It was also found that the CV value of the mixing degree of colored lactose having particle sizes of 60/100 and 42/60-mesh with diluent lactose having particle sizes of >100 -, 60/100-, 42/60- and 32/42-mesh became less than 6.08% after 60 rotations (Figs. 2 and 3).

Distribution of Particle Sizes after Mixing Distribution of particle sizes was examined after mixing colored lactose having particle size of 42/60-mesh with diluent lactose having particle size of 42/60-mesh. As shown in Table 1, after 100 rotations, 45% and 4% of the 42/60-mesh particles had become 60/100- and 100/150-mesh particles, respectively, due to the grinding/destruction of particles in the mortar. In contrast, only 12% of the 60/100-mesh particles had become 100/150-mesh particles after the mixing of 60/100-mesh particles (Table 2).

DISCUSSION

One of the most important factors that determine the degree of mixing in trituration is particle sizes of principal drugs and diluents. In the present study, we determined mixing degrees by using colored lactose. The CV value of mixing degree became less than 6.08 % after 40 rotations when colored lactose was mixed with diluent lactose whose particle sizes were the same as that of the colored lactose, except in the case of 42/60 mesh powder. Moreover, the CV value of mixing became less than 6.08% after 40 rotations when colored lactose with particle size of >100 -mesh was

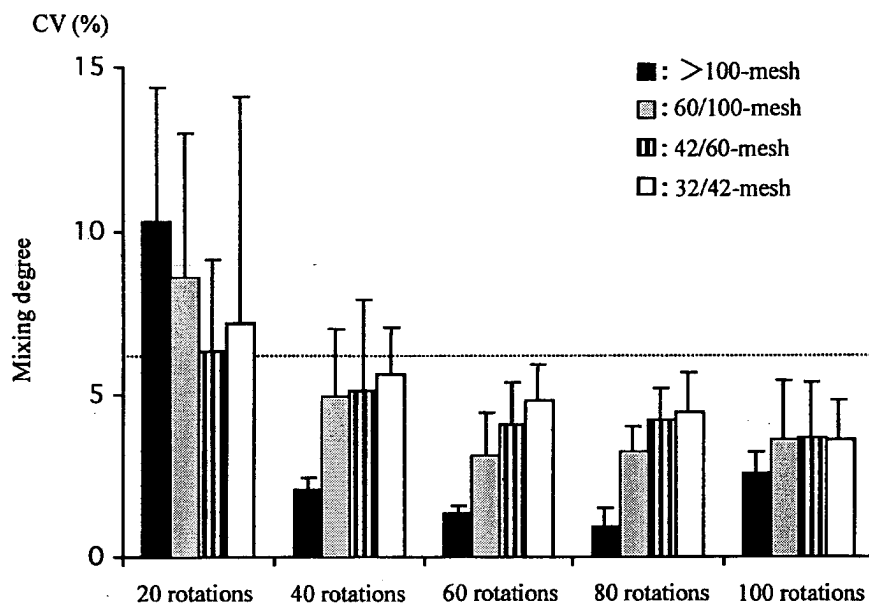


Fig. 1. Effect of Particle Size on Mixing Degree of >100-mesh Colored Lactose

Colored lactose having particle size of >100-mesh was mixed with the same amount of diluent lactose having particle sizes of >100-, 60/100-, 42/60- and 32/42-mesh. The mortar and pestle were rotated 20, 40, 60, 80 and 100 times. The results are given as CV value of the mixing degree. Each bar represents the mean \pm S.D. of three determinations.

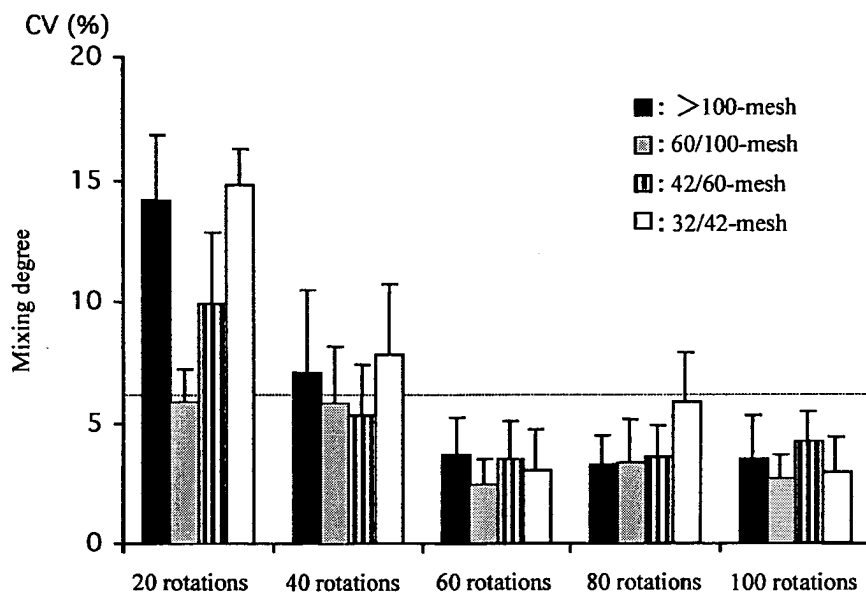


Fig. 2. Effect of Particle Size on Mixing Degree of 60/100-mesh Colored Lactose

Colored lactose having particle size of 60/100-mesh was mixed with the same amount of diluent lactose having particle sizes of >100-, 60/100-, 42/60- and 32/42-mesh. The mortar and pestle were rotated 20, 40, 60, 80 and 100 times. The results are given as CV of the mixing degree. Each bar represents the mean \pm S.D. of three determinations.

mixed with diluent lactose with particle size of >100-mesh, although we do not know the reason. It was also found that mixing degree was satisfactory when particle sizes of the colored and diluent lactose were the same than when they were different, especially for

small colored lactose samples.

In addition, the distribution of particle sizes was examined after mixing lactose powders whose particle sizes were 42/60- and 60/100-mesh. After 100 rotations, approximately 50% of the 42/60-mesh particles

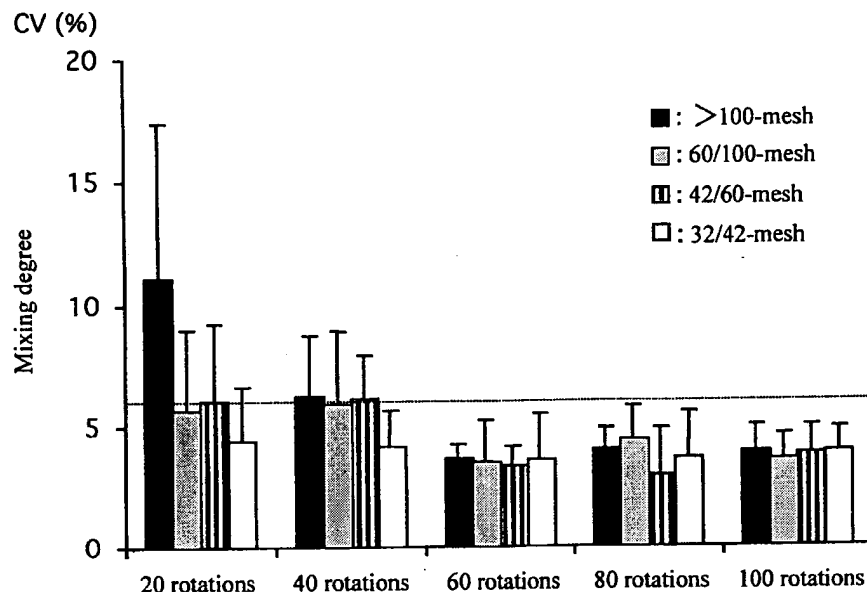


Fig. 3. Effect of Particle Size on Mixing Degree of 42/60-mesh Colored Lactose

Colored lactose having particle size of 42/60-mesh was mixed with the same amount of diluent lactose having particle sizes of >100-, 60/100-, 42/60- and 32/42-mesh. The mortar and pestle were rotated 20, 40, 60, 80 and 100 times. The results are given as CV of the mixing degree. Each bar represents the mean \pm S.D. of three determinations.

Table 1. Alterations in Particle Size Caused by Mixing of 42/60-Mesh Powders

| Particle size | Mean \pm S.D. (%) |
|---------------|---------------------|
| 42/60-mesh | 48.6 \pm 3.5 |
| 60/100-mesh | 45.3 \pm 4.2 |
| 100/150-mesh | 3.8 \pm 0.2 |
| 150/200-mesh | 0.9 \pm 0.3 |
| >200-mesh | 1.4 \pm 0.5 |
| Total | 100 |

Powder with particle size of 42/60-mesh was mixed in a mortar and a pestle by 100 rotations. After mixing, particle size was determined using dispensing sieves. Each value is the mean \pm S.D. of three determinations.

Table 2. Alterations in Particle Size Caused by Mixing of 60/100-Mesh Powders

| Particle size | Mean \pm S.D. (%) |
|---------------|---------------------|
| 60/100-mesh | 85.3 \pm 3.2 |
| 100/150-mesh | 12.3 \pm 1.8 |
| 150/200-mesh | 0.8 \pm 0.2 |
| >200-mesh | 1.6 \pm 0.2 |
| Total | 100 |

Powders with particle size of 60/100-mesh was mixed in a mortar and pestle by 100 rotations. After mixing, particle size was determined using dispensing sieves. Each value is the mean \pm S.D. of three determinations.

became smaller, whereas only 12% of the 60/100-mesh particles had become 100/150-mesh particles (Table 2). It was suggested that, in contrast to powders with small particle sizes, the mixing of large granules in the mortar results in an altered distribution of particle sizes. In preliminary experiments, we examined the distribution of particles by using a coated mortar, shaker and dispensing spoon. Forty five percent and 4% of the 42/60-mesh particles became 60/100- and 100/150-mesh particles, respectively, when a coated mortar and shaker were used. These results are consistent with the results obtained by using a regular mortar. In addition, 38% of the 42/60-mesh particles became 60/100-mesh particles after

mixing with a dispensing spoon. Taken together, the results indicate that alterations in the distribution of particle sizes occur after mixing using a regular or coated mortar, a shaker, and a dispensing spoon instead of a pestle.

Concerning the selection of diluents for preparation of triturations of granules, Aoki *et al.*⁷⁾ and Kobo *et al.*¹⁰⁾ reported that the diluent powder that passed through a 35-mesh sieve and powder that passed through a 50-mesh sieve but was trapped by 100-mesh sieve were suitable. Kozatani *et al.*⁹⁾ reported that the diluent powder that passed through a 36-mesh sieve but was trapped by 65-mesh sieve was suitable considering convenience in handling (such as

4/5

mixing degree, repose angle and elusion coefficient). However, the distributions of particle sizes of powders and fine granules are different from each other, which is based on the definition of fine granules in the Japanese Pharmacopeia. Fine granules are defined in the 9th and 10th editions of the Japanese Pharmacopeia as particles for which less than 10% pass through a 200-mesh sieve. In contrast according to the Requirements for Antibiotic Products of Japan, 1993, fine granules are defined as particles for which more than 95% pass through a 32-mesh sieve. Consequently, the distribution of particle sizes of commercially available fine granules which consist of principal drugs is different from each other depending on the products. For example, approximately 10%, 18%, 37% and 34% of commercially available Aleviatin fine granules are 32/42-, 42/60-, 60/100- and >100-mesh particles, respectively, whereas approximately 62% of commercially available Serenace fine granules are trapped on a 48 mesh sieve. It is therefore possible that the degree of mixing of fine granules with powders is affected not only by the distribution of particle sizes but also by the degree of hardness of fine granules, since fine granules with a low degree of hardness may become smaller during mixing.

From these findings, it was suggested that the mixing degree is affected by the distribution of particle sizes but that 60 rotations may result in excellent mixing for particles of less than 32/42-mesh in size. For

preparation of triturations from fine granules with relatively large diameters, the degree of hardness of the fine granules may affect the mixing degree, since fine granules with a low degree of hardness may become smaller during mixing.

REFERENCES

- 1) Okada J., Matsuda Y., Morita O., Wada Y., Onishi H., *Yakugaku Zasshi*, **88**, 827-831 (1968).
- 2) Okada J., Matsuda Y., Fukumori Y., *Yakugaku Zasshi*, **92**, 270-274 (1972).
- 3) Awata E., Ohtsuka K., Morioka T., Ikegami Y., *Yakuzaigaku*, **19**, 141-144 (1959).
- 4) Ueno T., Saito M., Suzuki K., *Yakuzaigaku*, **19**, 244-247 (1959).
- 5) Yamana T., Minakami Y., Ichimura F., Isemi Y., *Yakuzaigaku*, **32**, 21-26 (1972).
- 6) Sakurai K., Fujii S., Ito S., *Yakuzaigaku*, **16**, 7-12 (1956).
- 7) Aoki D., Fukuda T., Ueda S., Mochiduki A., *Yakuzaigaku*, **27**, 106-108 (1967).
- 8) Nakamura H., Higo K., Suzuki A., Fujinuma Y., Tanaka Y., Ohtani M., Kotaki H., Iga T., *Jpn. J. Hosp. Pharm.*, **23**, 306-311 (1997).
- 9) Kozatani J., Kitaura T., Ashida K., *Yakuzai-gaku*, **29**, 53-56 (1969).
- 10) Kobo B., Inoue S., *Jpn. J. Hosp. Pharm.*, **3**, 215-219 (1978).